

## STUDIES IN THE SIMAROUBACEAE, I THE GENUS CASTELA

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EXTENSIVE chemical studies now in progress in the laboratories of Merck & Co., at Rahway, New Jersey, have rendered desirable systematic reviews of several genera of the Simaroubaceae. In the course of this work I intend to revise the New World representatives of the family. A comprehensive delimitation of the genera will be presented in due time.

The genus *Castela* was proposed by Turpin in 1806, with *C. depressa*, from the present Dominican Republic, as the type species. A second species, *C. erecta*, from Antigua, was described at the same time. Turpin wrote, and his figure clearly indicates, that *C. depressa* has a long slender style and a capitate slightly lobed stigma. He did not illustrate the flowers of *C. erecta*, but said that they "ne m'ont paru avoir aucune difference remarquable."

*Castela erecta* has been identified beyond doubt, and it has a short style column with divergent stigmas, as do all subsequently described species of the genus. Small<sup>1</sup> seized upon the supposed difference in styles and segregated all the species except *C. depressa* as a new genus, *Castelaria*. He apparently had no material of *C. depressa*, but took its character from Turpin's description. Material now available from the Dominican Republic has a short style column and long, recurved, almost circinately rolled stigmas, but is otherwise rather similar to Turpin's figure. No other species of *Castela* is known from the Dominican Republic, and *C. erecta*, which it most nearly resembles, approaches no nearer than St. Croix. The probability is that Turpin's description and figure are in error, and I am treating the recently collected plants from the Dominican Republic as *C. depressa*.

At the time he segregated the genus *Castelaria*, Small replaced the name *Castela* Turp. with *Neocastela* Small, rejecting the former because of its similarity to *Castelia* Cav., 1801, which is generally regarded as a synonym of *Priva*. However, *Castela* Turp. has recently been conserved (Kew Bull. **1940**: 108. 1940).

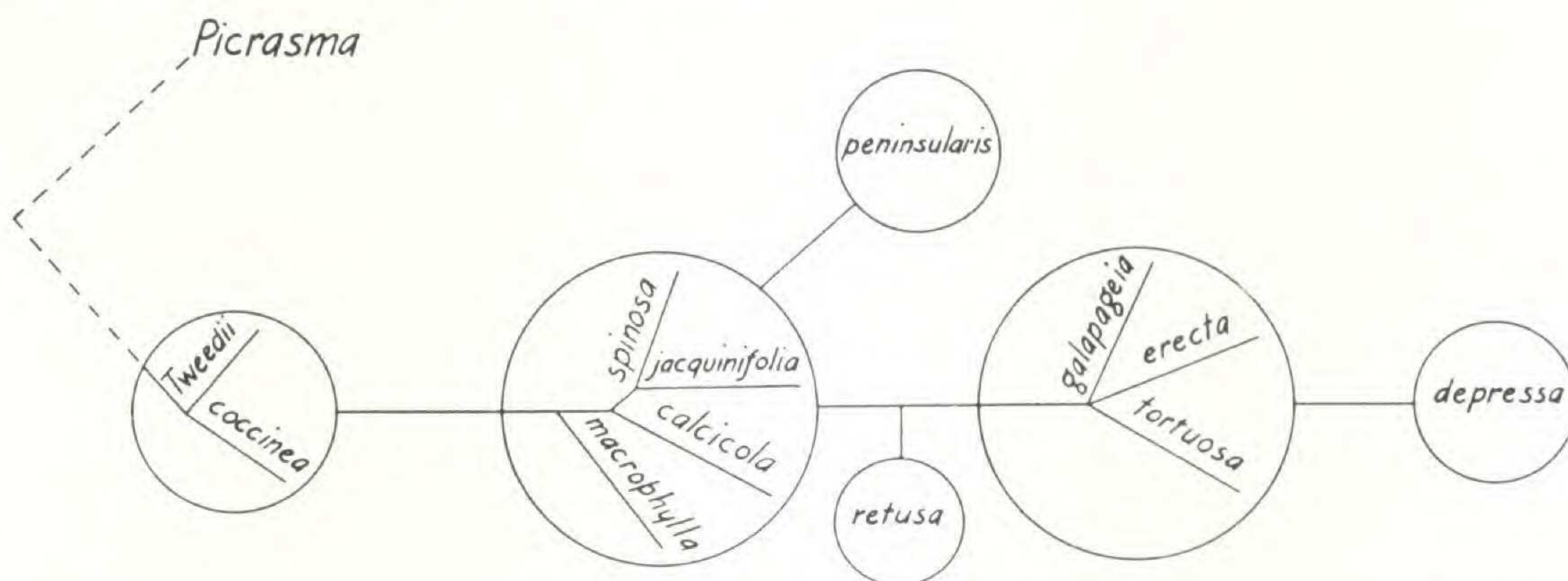
Aside from the ditypic *Holacantha*, which appears to be a specialized offshoot of *Castela*, the latter seems most closely related to *Picrasma* (*sens. lat.*, including *Aeschrion*), some species of which show a tendency toward reduction in size and number of leaflets, the leaflets resembling the leaves of *Castela*. The chief difference in flowers is that *Castela* has 8 stamens, whereas *Picrasma* has only 4.

There are several obvious species-groups in the genus *Castela*. *Castela erecta*, *C. galapageia*, and *C. tortuosa* are closely related and only doubt-

<sup>1</sup>Small, J. K. Simaroubaceae. N. Am. Fl. **25**: 227-239. 1911.



fully distinct. Presumably they had a common ancestor in relatively recent time. Three Cuban and one Jamaican species form another closely knit group: *C. spinosa*, *C. jacquinifolia*, *C. calcicola*, and *C. macrophylla*. The characters on which these are separated are minor, and they too would seem to have had a recent common ancestor. A third group is formed by *C. Tweedii* and *C. coccinea*, of South America. Though obviously related, these two species are amply distinct. Of the three remaining species, *C. peninsularis* seems to be an offshoot of the *C. macrophylla* group, *C. retusa* forms a connecting link between the *C. macrophylla* and *C. erecta* groups, and *C. depressa* is evidently related to *C. erecta*. A tentative phylogenetic arrangement is given below.



The geographic distribution of the species of *Castela* suggests that formerly continuous ranges have been broken up and are being progressively restricted. Even within the area of a single species, such as *C. tortuosa*, observations by collectors indicate that, while individuals are found in abundance in a given patch, it may be many miles between patches. Similarly, *C. erecta* is apparently found on relatively few of the West Indian islands, although more collecting will presumably increase the number of known stations.

I wish to thank Dr. R. T. Major, Director of the Research Laboratory of Merck & Co., Inc., who made this study possible, Dr. H. A. Gleason and Mr. B. A. Krukoff, of the New York Botanical Garden, who have given helpful advice and criticism and aided in obtaining necessary material, and the curators of the following herbaria (designated hereinafter by the letters at the left), who have loaned specimens for study:

- A — Arnold Arboretum, Harvard University,
- F — Field Museum of Natural History, Chicago,
- G — Gray Herbarium, Harvard University,
- Mich — University of Michigan, Ann Arbor,
- Mo — Missouri Botanical Garden, St. Louis,
- NY — New York Botanical Garden,
- US — United States National Herbarium, Washington, D. C.,
- Y — Yale University School of Forestry, New Haven, Conn.

Specimens cited as Kr. Herb. are mostly vouchers received by Mr.



Krukoff in connection with samples for chemical analysis. Most of the Gray Herbarium material was examined at Harvard, and only critical specimens are cited.

KEY TO THE SPECIES

1. Filaments very conspicuously thickened toward the base; plants of northern Argentina and adjacent area.
  2. Flowers delicate, the petals mostly 3–3.5 mm. long, the anthers mostly 1.2–1.5 mm. long; leaves downy-pubescent with spreading hairs to essentially glabrous beneath, essentially glabrous above except for some fine hairs along the midrib; spines slender, mostly unbranched and not more than 2 cm. long. . . . .2. *C. Tweedii*.
    3. Leaves essentially glabrous beneath. . . . .2a. *C. Tweedii* var. *typica*.
    3. Leaves downy-pubescent beneath. . . . .2b. *C. Tweedii* var. *macrophylla*.
  2. Flowers larger and coarser, the petals mostly 4.5–5 mm. long, the anthers mostly 2–2.5 mm. long; leaves with a fine and closely appressed yellowish and somewhat glutinous-appearing pubescence beneath (occasionally becoming subglabrate at maturity), glabrous above, or slightly pubescent like the lower surface; spines coarse, commonly branched, often well over 2 cm. long. . . . .1. *C. coccinea*.
1. Filaments only slightly or moderately thickened toward the base; plants of the Galapagos Islands, Colombia, Venezuela, the West Indies, Mexico, and southern U. S. A. (Texas).
  2. Leaves white-tomentose beneath, shining and glabrous or nearly so above; young twigs conspicuously white- or gray-tomentose except in *C. retusa*, where merely puberulent.
    3. Leaves mostly well over 1 cm. long and more than half as wide, rounded to retuse and sometimes mucronulate at the apex; tomentum thin and sparse; young twigs densely puberulent, but not tomentose; plant of Oaxaca, Mexico. . . . .8. *C. retusa*.
    3. Leaves when over 1 cm. long not more than half as wide, acute to obtuse or sometimes rounded at the apex, often mucronulate, but not retuse; tomentum dense; young twigs tomentose.
      4. Trailing or ascending shrub of the Dominican Republic; style branches recurved, almost circinately rolled; leaves rounded to subcordate at the base. . . . .12. *C. depressa*.
      4. Erect shrubs, not of the Dominican Republic; style branches stiffly spreading; leaves acute to rounded at the base, but scarcely subcordate.
        5. Network of veins on the lower surface of the leaves raised and conspicuous to the naked eye; veins glabrous, or less densely pubescent than the areolae; plant of the Galapagos Islands. . . . .10. *C. galapageia*.
        5. Network of veins on the lower surface of the leaves usually inconspicuous when viewed with the naked eye; veins equally as pubescent as the areolae.
          6. Leaves mostly over 1.5 cm. long; network of veins on the lower surface of the leaves readily evident when viewed with a lens; plant of northern Colombia and Venezuela and the West Indies. . . . .11. *C. erecta*.
          6. Leaves mostly 1.5 cm. long or less; network of veins on the lower surface of the leaves usually relatively obscure even when viewed with a lens; plant of southern Texas, U. S. A., to Oaxaca, Mexico. . . . .9. *C. tortuosa*.
    2. Leaves glabrous or pubescent above and beneath, but not white-tomentose; young twigs variously pubescent, but not tomentose.
      3. Leaves appearing dull, copiously pubescent with spreading hairs beneath, similarly but less densely pubescent above; twigs pubescent like the lower surfaces of the leaves; plant of Baja California, Mexico. . . . .7. *C. peninsularis*.
      3. Leaves shining, glabrous or hispidulous to puberulous on one or both surfaces; twigs variously pubescent; plants of the West Indies.



4. Leaves glabrous, except sometimes for a few small hairs on the midrib; petals glabrous, 3–4 mm. long; plant of Oriente, Cuba. 5. *C. jacquinifolia*.
4. Leaves sparsely to moderately hispidulous or hirtellous at least beneath, also above except sometimes in *C. macrophylla*; plants of Jamaica and western Cuba.
5. Plant very thorny, the thorns long, stout, and branched; petals hispidulous, 4–4.5 mm. long; plant of western Cuba. . . . . 6. *C. spinosa*.
5. Plant only slightly or moderately thorny, the thorns mostly simple and short, or wanting.
6. Leaves rounded or retuse at the apex, sparsely to moderately hispidulous on both sides; petals hispidulous, 3.5–4 mm. long; plant of western Cuba. . . . . 4. *C. calcicola*.
6. Leaves acute at the apex, except on vigorous young shoots, sparsely to moderately hirtellous or hispidulous beneath, often glabrous above; petals slightly hispidulous or glabrous, 2.5–3 mm. long; plant of Jamaica. . . . . 3. *C. macrophylla*.

## CATALOGUE AND COMMENTS

1. *Castela coccinea* Griseb. Abh. Ges. Wiss. Goett. **19**: 107. 1874.

TYPE: *Lorentz & Hieronymus 514*, "in fruticetis Sierra Cordoba occidentalibus." Cordoba, Argentina (F-photo, NY-photo).

DISTRIBUTION: Known only from northern Argentina and adjacent Paraguay.

ARGENTINA: *Lorentz & Hieronymus 40* (F, US), *570* (NY); J u j u y : *Eyerdam & Beetle 22498* (Mo); S a l t a : *Eyerdam & Beetle 22892* (Mo); *Venturi 9497* (A, Mo, US); T u c u m á n : *Venturi 1391* (A, US); S a n t i a g o d e l E s t e r o : *Venturi 9731* (A, Mo, US); C h a c o : *Jorgensen 1951* (Mo, US); *Schulz s.n.* (Kr. Herb. #16378A). PARAGUAY: *Rojas 2450* (US).

Collectors' notes indicate that this species is a shrub up to about 3 meters high. The pubescence on the lower surface of the leaves is sometimes so fine as to escape notice except under very careful observation with a good lens. There is a noticeable though scarcely tangible difference in the texture of the leaves of this and *C. Tweedii*, and these two may likewise be separated from other species of the genus by intangibles of leaf character and venation, after a little experience with the group.

2. *Castela Tweedii* Planch. Lond. Jour. Bot. **5**: 569. 1846.2a. *Castela Tweedii* var. *typica* nom. nov.

*Castela Tweedii* Planch. Lond. Jour. Bot. **5**: 569. 1846.

? *Castela alaternifolia* Planch. loc. cit. "Chili absque loco proprio." No members of the Simaroubaceae are known to occur in Chile, and the description suggests a broad-leaved form of *C. Tweedii*.

*Castela Tweedii* var. *dentata* Engl. Nat. Pfl. **3**<sup>4</sup>: 219. 1896.

TYPE: *Tweedie s.n.*, "Parana et Banda oriental," Brazil.

DISTRIBUTION: Known from Uruguay to Paraguay and adjacent Brazil.

URUGUAY: *Ball s.n.*, in 1882 (NY); *Lorentz s.n.*, October 30, 1875 (F-photo). ARGENTINA: E n t r e R i o s : *Baez s.n.* (Kr. Herb. #16371); C o r r i e n t e s : *Bonpland 1205* (NY), *1207* (NY). PARAGUAY: *Hassler 11042* (A), *11063* (A).

2b. *Castela Tweedii* var. *macrophylla* Chod. & Hass. Bull. Herb. Boiss. II. **3**: 800. 1903.

TYPE: *Hassler 736*, "in dumetis Cordillera de Altos," Paraguay (NY, isotype).

DISTRIBUTION: Known only from Paraguay.

PARAGUAY: *Fiebrig 7* (A, F, US); *Hassler 3025* (A), *11792* (A, F, Mo), *11792a* (A, Mo), *12801* (A, Mo).



This species is reported to reach tree size, but the type of var. *macrophylla* was described as a shrub 3–4 meters high. The variety *macrophylla* was founded on the size of the leaves, which is of no taxonomic significance in this case, but the type happens to belong to the pubescent-leaved phase of the species, so that the inappropriate name must be preserved.

3. **Castela macrophylla** Urb. Symb. Ant. **5**: 377. 1908.

*Castelaria macrophylla* Small, N. Am. Fl. **25**: 232. 1911.

TYPE: *Harris 9219*, Great Goat Island, Jamaica (F, NY, isotypes).

DISTRIBUTION: Confined to Jamaica.

JAMAICA: *Britton 1295* (NY), *2825* (NY); *Britton & Hollick 1843* (NY, US); *Harris 9347* (A, NY, US), *9348* (A, NY), *10047* (NY), *12471* (Mo, NY, US); *Lorter s.n.* (Kr. Herb. #16317).

4. **Castela calcicola** (Britton & Small) Ekman ex Urb. Repert. Sp. Nov. **20**: 304. 1924.

*Castelaria calcicola* Britton & Small, Bull. Torrey Club **44**: 34. 1917.

TYPE: *Shafer 13434*, limestone hills, vicinity of Sumidero, Pinar del Rio, Cuba (NY); isotype (Mo).

DISTRIBUTION: Known only from Pinar del Rio, Cuba.

CUBA: Pinar del Rio: *Britton & Cowell 9981* (NY); *Shafer 13386* (NY, US).

5. **Castela jacquinifolia** (Small) Ekman ex Urb. Repert. Sp. Nov. **20**: 304. 1924.

*Castelaria jacquinifolia* Small, N. Am. Fl. **25**: 232. 1911.

TYPE: *Britton 2198*, Leeward Point, Guantanamo Bay, Oriente, Cuba (NY).

DISTRIBUTION: Known only from Oriente, Cuba.

CUBA: Oriente: *Clement 107* (NY), *155* (NY).

6. **Castela spinosa** sp. nov.

Frutex spinosissimus, spinis longis ramosis, ramulis hirtellis; foliis nitidis utrinque hirtellis ex late lanceolatis oblongisve ellipticis vel subrotundis, obtusis vel acutis, perspicue reticulato-venosis, circa 1–2 cm. longis et 4–10 mm. latis; petalis coccineis hispidulis 4–4.5 mm. longis; antheris circa 2–2.5 mm. longis; drupis coccineis circa 1 cm. longis.

TYPE: *Shafer 11082*, rocky places, Las Martinas to the Coast, Pinar del Rio, Cuba, December 19, 1911 (NY); isotype (US).

DISTRIBUTION: Pinar del Rio and Habana, Cuba.

CUBA: *Hioram 2186* (NY); *Wright 2193* (Mo, NY, US); *H a b a n a*: *Leon 7219* (NY); *Pinar del Rio*: *Acuna s.n.* (Kr. Herb. #16467); *Roig 3931* (NY).

This species was first recognized by Percy Wilson, who assigned it the same epithet here used, in an unpublished combination under *Castelaria*. It is the *C. erecta*, in large part, of Small's treatment in North American Flora, but it is not closely related to the original *Castela erecta* Turp.

7. **Castela peninsularis** Rose, Contr. U. S. Nat. Herb. **12**: 278. 1909.

*Castelaria peninsularis* Small, N. Am. Fl. **25**: 231. 1911.

TYPE: *Purpus 244*, San José del Cabo, Baja California, Mexico.

DISTRIBUTION: Baja California, Mexico, especially near the coast, from Magdalena Bay around the cape to Santa Catalina Island.

MEXICO: Baja California: *Brandegge s.n.*, October 29, 1893 (NY), January, 1889 (A); *Collins, Kearney, & Kempton 124* (US); *Johnston 3918* (US), *3928* (A, Mo, NY), *3983* (US); *Rose 16295* (NY, US), *16399* (NY, US), *16547* (US), *16850* (NY, US), *16865* (US), *16909* (US).



8. *Castela retusa* Liebm. Vidensk. Meddel. **1853**: 108. 1854.

TYPE: *Liebmann s.n.*, between Tehuantepec and Oaxaca, Oaxaca, Mexico (F-photo).

DISTRIBUTION: Known only from Oaxaca, Mexico.

MEXICO: Oaxaca: *Seler 1749* (G).

This species connects the *C. erecta* group with the *C. macrophylla* group. The tomentum on the lower surface of the leaves is sparser and much less conspicuous than in *C. erecta* and its allies, and the leaves are otherwise suggestive of the *C. macrophylla* group. It is apparently rare, being known from only one collection besides the type.

9. *Castela tortuosa* Liebm. Vidensk. Meddel. **1853**: 108. 1854.

*Castela Nicholsoni*  $\beta$  *texana* Torr. & Gray, Fl. N. Am. **1**: 680. 1840.

*Castela texana* Rose, Contr. U. S. Nat. Herb. **12**: 278. 1909.

*Castelaria texana* Small, N. Am. Fl. **25**: 231. 1911.

*Castelaria tortuosa* Small, *loc. cit.*

? *Castela salubris* Boas, Beih. Bot. Centr. **29**<sup>1</sup>: 342. 1913. If the statement in the original description that the petals of *C. salubris* are only 1.5 mm. long applies to boiled flowers, the plant deserves some sort of segregation from typical *C. tortuosa*.

*Castela salubris* var. *Endlichiana* Boas, Repert. Sp. Nov. **12**: 224. 1913.

TYPE: *Liebmann 4252*, Tehuacan de las granadas, Puebla, Mexico (US, isotype).

DISTRIBUTION: Oaxaca, Mexico, to southern Texas, U. S. A.

MEXICO: *Gregg s.n.*, May, 1847 (NY); Oaxaca: *Gonzalez 984* (US); *Liebmann 4252* (but data not as the type) (F); *Nelson 1885* (US); Puebla: *Liebmann 15053* (F); *Rose, Painter, & Rose 10007* (NY, US); San Luis Potosi: *Salazar s.n.*, February 22, 1913 (US); Tamaulipas: *Bartlett 10720* (A, F, US), *11015* (F, US), *11173* (F); *LeSueur 236* (F); *Nelson 6614* (US); *Palmer 121* (Mo, US), *129* (US); *Parry et al. 160* (NY, US); *Sours s.n.* (Kr. Herb. #16001); *von Rozynski 743* (F, NY); *Wizlizenus 366* (Mo); *Wooton s.n.*, June 21, 1919 (US); Nuevo Leon: *Edwards 391* (F); *Taylor 391* (Mo); *Thurber 863* (NY); *Wizlizenus 323* (Mo); Coahuila: *Kenoyer 28* (F); *Parry & Palmer 107* (Mo, US); Chihuahua: *Wizlizenus 254* (Mo). UNITED STATES: Texas: *Ferris & Duncan 3061* (Mo, NY); *Heller 1402* (Mo, NY, US); *Howard s.n.*, 1892 (Mich, NY); *Jermy s.n.*, in 1904 (Mo, US); *Mackenzie 44* (Mo, NY); *Palmer 152* (Mich, Mo); *Palmer 12951* (A, Mo); *Wright 85* (NY, US).

Collections from Texas are so numerous that I have cited only a small proportion of them.

The difference between *C. tortuosa* and *C. erecta* in prominence of the veins of the leaves is neither very great nor entirely constant, yet it is helpful after one has established some standards by comparison of specimens of each.

10. *Castela galapageia* Hook. f. Trans. Linn. Soc. **20**: 229. 1851.

*Castelaria galapageia* Moldenke, Phytologia **1**: 8. 1933.

TYPE: *Darwin s.n.*, Chatham Island, Galapagos Islands.

DISTRIBUTION: Galapagos Islands.

GALAPAGOS ISLANDS: *Stewart 1750* (US), *1754* (US), *1759* (US), *1761* (US); *Wheeler, Rose, & Beebe 43* (NY), *50* (NY, US).

This species seems to have retained wide variability in leaf size, whereas *C. tortuosa* has become relatively small-leaved and *C. erecta* has become relatively large-leaved in most cases. Several forms have been described,



but intensive study by Stewart<sup>2</sup> has shown that these have no taxonomic value.

11. **Castela erecta** Turp. Ann. Mus. Par. **7**: 80. t. 5B. 1806.

*Castela Nicholsoni* Hook. Bot. Misc. **1**: 271. 1830.

*Castelaria Nicholsoni* Small, N. Am. Fl. **25**: 231. 1911.

*Castelaria erecta* Small (as to name), *loc. cit.* 232.

TYPE: *Richard s.n.*, Antigua, West Indies.

DISTRIBUTION: Known from northern Colombia and Venezuela, and Margarita, Cubagua, Antigua, and St. Croix Islands; to be expected on some of the other islands of the West Indies.

COLOMBIA: *Dawe 517* (US). VENEZUELA: *Curran & Haman 429* (US); Sucre: *Curran & Haman 1249* (A, NY, US); Lara: *Saer 23* (US); Zulia: *Pittier 10546* (NY, US); Nueva Esparta: Cubagua: *Cooper 216* (NY, US, Y); Margarita: *Johnston 118* (NY, US); *Miller & Johnston 236* (F, Mo, NY, US). ST. CROIX: *Britton, Britton, & Kemp 55* (NY, US); *Haukien s.n.* (NY); *Ricksecker 377* (Mo, NY, US); *Rose, Fitch, & Russell 3529* (NY, US); *Thompson 176* (NY). ANTIGUA: *Box 738* (US); *Nicholson s.n.*, September 26, 1850 (NY); *Warneford s.n.* (Kr. Herb. #16434).

Some specimens from Venezuela have the leaves no longer than is usual for *C. tortuosa*, though they are generally somewhat broader. *C. erecta*, *C. galapageia*, and *C. tortuosa* are very closely related, and accumulation of more material may force their combination into one species. Until then, in view of their geographic segregation, I think it best to continue the traditional treatment of regarding them as distinct, although I realize that the lines between them are very tenuous.

12. **Castela depressa** Turp. Ann. Mus. Par. **7**: 79. t. 5A. 1806.

*Neocastela depressa* Small, N. Am. Fl. **25**: 230. 1911.

TYPE: *Turpin s.n.*, "Ile de Saint-Domingue, entre Mont-Christ et Saint-Yague," Dominican Republic.

DISTRIBUTION: Known only from the Dominican Republic.

DOMINICAN REPUBLIC: *Jimenez 6018* (Herb. Jimenez); *Jimenez s.n.* (Kr. Herb. #16134).

#### DOUBTFUL OR EXCLUDED SPECIES

*Castela lychnophoroides* Liebm. Vidensk. Meddel. **1853**: 111. 1854. Described without flowers or fruit, and probably not a *Castela*.

*Castelaria Brittonii* Small, N. Am. Fl. **25**: 232. 1911 = **Henoonia Brittonii** (Small) Monachino.

*Castela Brittonii* (Small) Engl. Nat. Pfl. II. **19a**: 385. 1931 = *praec.*

NEW YORK BOTANICAL GARDEN,  
NEW YORK.

<sup>2</sup>Stewart, A. Am. Jour. Bot. **2**: 279-288. 1915.